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‘Design scrying’ is the generation of images through interface distortions that occur at reflective surfaces. ‘Dark gels’ are used as an image generating system for an alternative aesthetics of life.

Design scrying: an alternative aesthetics for synthetic biology

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In 1911, Stephane Leduc originally proposed that synthetic biology is a branch of synthetic chemistry that can offer a portfolio of design tools that broaden the possibilities of an aesthetics of life. In the production of generative fields that underpin the synthesis of living systems, life-like materials may be transfigured and transformed without being constricted by naturalistic expectations. The role of ‘design scrying’ in this exploration is discussed particularly in the generation of images through the interface distortions that occur at the surfaces of ‘dark gels’. These non-deterministic image generating media enable discussion of the aesthetics of life that enable designers to venture beyond the conventions of representation in the natural sciences and synthetic biology, as it is currently practiced in scientific laboratory settings. The implications of this approach are considered through the possibility of using lifelike materials in the choreography of space where lifelike materials, trembling interfaces and living technologies give rise to the emergence ‘soft living architectures’. These establish the possibility of the development of living spaces that possess some of the properties of living things but may not have the full status of being truly alive.

Subheading in text

“Affirming that the universe resembles nothing and is only formless amounts to saying that the universe is something like a spider, or spit.” Georges Bataille [[Bois, Y.A. and Krauss. R.E. (1997). Formless: A user’s guide. New York: Zone Books, p5.]]

How do we generate a new aesthetic for nature when our traditions have largely represented biology through naturalised mimetics and geometric formulae?

Stephane Leduc’s 1911 paper on the mechanism of life takes a particular view of biology where he proposes that it is simply a more complex form of chemistry. In this worldview it becomes possible to construct living things by a detailed understanding of their chemical constituents. According to Leduc it is therefore possible to build biological systems by an extremely detailed knowledge of their constituents and considers this as a new scientific discipline called synthetic biology [[Leduc, S. (1911). *The Mechanism of Life*. Butcher, W.D. translation. London: William Heinemann.]]. In these days before genetics Leduc regards synthetic biology as being a more complex branch of synthetic chemistry. He sets out a set of chemical experiments in which nonliving matter takes on dynamic qualities of growth and movement

that are typically ascribed to living things. He also prioritizes form over physiology (or function) and pays close attention to the production of 'osmotic' structures that he likens to the growth of fungi, where the movement of water through semi permeable, inorganic membranes produces striking lifelike phenomena.

In the 1970s the rise of molecular biology, created a need for a market for biotechnological products and reappropriated the term synthetic biology to the genetic revolution. Specifically, in 1974, the Polish geneticist Waclaw Szybalski used the term "synthetic biology" to refer to the development of control elements for genes that were modularized to direct the operations of existing genomes or build up wholly new genomes. In this manner, whole new kinds of biological system could be called into existence. This interpretation of synthetic biology is predominately used in modern scientific laboratories. Definitions of synthetic biology further differentiate from biotechnology through allying with the latest genetic technologies that indicate increasing specificity in manipulating Deoxyribose Nucleic Acid, or DNA [[Armstrong, R. 2013. Coming to terms with synthetic biology, Everything under control, Volume Magazine, Archis Press, No.35, pp. 110-117.]].

Biological determinism and the laws of accident

Yet, the issue of biological determinism is problematic – the idea that it is possible procedurally to preordain outcomes by knowledge of information stored by genetic code. Deterministic theories of life propose that organisms follow an idealised genetic program. This is encoded in the biological molecule DNA, which contains instructions to make objects from constituent proteins. During this process the cell apparatus that copies, translates and synthesises these molecules and in the process, makes 'errors'. These systemic faults are proposed to underpin evolutionary change.

The challenge for pre-ordained outcomes is that they need to anticipate all possible changes to optimize survival. Deterministic strategies are not sensitive to changing environmental conditions, a characteristic that is shared with 'machines,' which also largely possess bodies that are operated by receiving centralized instructions. Yet, environmental sensitivity is something that Charles Darwin noted was fundamental to evolutionary processes. In fact, deterministic notions of biology invoke a strategy for change that relies solely upon a theory of accident, whose modus operandi is not at all well articulated in scientific or cultural terms. Specifically, 'error' is not defined against a background value system against which the biological programs make decisions. Moreover, "random" is a statistic, not a survival strategy.

Yet determinism does not rule out the contribution of landscapes and environments. Rather, they invoke a mysterious process of natural selection, which is capable of selecting favourable errors (again, against an uncharacterised, and undeclared value landscape) and so, upgrade the replicating system towards some inevitably progressive state. Since the final outcomes are already pre-determined accounts of change are better post-rationalised than predicted. This is due to the massive phase space that exists between an organism and its environment whereby, as Stuart Kauffman observes,

"*…we cannot analyze or understand an organ's function except in the context of its entire lifecycle in its selective environment, and in the context of the selective history underlying its evolution. We need to know some of the evolutionary history of the biosphere to say anything about evolved functions*." [[Kauffman, S.A. (2008). *Reinventing the Sacred: A new view of science, reason, and religion*. First trade paper edition. New York: Basic Books, p34.]]

Therefore, in evolutionary theories that centre on biological determinism, the principles of change are in conflict with the idea that fate of living things is already established. This logical fallacy in the design approach is witnessed in biological terms where 'error' and 'accident' tend to be terminal events for living systems. Indeed, cells possess many counter strategies to resist spontaneous errors during biochemical processes. Organisms have repair systems, defence strategies and change their behaviour to alter the way they operate. If biological determinism is to convincingly situate random processes as a highly successful strategy that can rapidly and persistently manipulate extremely complex and robust systems then a new theory of 'accident' or 'error' is needed.

A more plastic and permissive model of biological identity that enables change and equips organisms with robustness in executing the operations of life is needed. Such ideas need to embrace change as integral to survival by enabling assaults on living systems to generate pressures within chemical

networks that reinforce their integrity. They should also offer a recombinant platform that facilitates the emergence of novelty and enables us to observe aspects of re-evolutionary pathways that begin to discuss an alternative story of life as proposed by Stephen Gay Gould. He proposed that replaying the Tape of Life could test whether the natural realm had been generated through a dominant program, such as one produced by an omnipotent divinity [[Gould, S.J. 1990. Wonderful Life: Burgess Shale and the nature of history. London: Vintage.]] . Gould argued that if we lived in a predetermined universe – then biological species would be very similar to those we recognize today. However, if environmental influences played a significant role in evolution, we might encounter seemingly alien kinds of life. Artistically, such possibilities speak to Gustav Flaubert's epic The Temptation of St. Anthony an encounter with dark forces during which the divine order, or tree of life, is deconstructed and re-proposed.

"*I hasten the dissolution of matter."*
"I facilitate the scattering of germs!"…
And, next, the plants are indistinguishable from the stones.
Pebbles bear a resemblance to brains, stalactites to udders, and iron-dust to tapestries adorned with figures. In pieces of ice he can trace efflorescences, impressions of bushes and shells—so that one cannot tell whether they are the impressions of those objects or the objects themselves. Diamonds glisten like eyes, and minerals palpitate…
"O bliss! bliss! I have seen the birth of life; I have seen the beginning of motion. The blood beats so strongly in my veins that it seems about to burst them. I feel a longing to fly, to swim, to bark, to bellow, to howl. I would like to have wings, a tortoise-shell, a rind, to blow out smoke, to wear a trunk, to twist my body, to spread myself everywhere, to be in everything, to emanate with odours, to grow like plants, to flow like water, to vibrate like sound, to shine like light, to be outlined on every form, to penetrate every atom, to descend to the very depths of matter—to be matter!"

[[Flaubert, G. 1904.The Temptation of St. Antony; Or, A Revelation of the Soul by Gustave Flaubert. Volume VII. Chicago: Simon P. Magee, pp.169-170.]]

In other words, we need a probabilistic, contingent model of life and theory of change, which does not pander to notions of idealised forms, functions, or the laws of chance (or the divine) but speaks to a more plastic, permissive and robust theory of existence.

Aesthetics as synthesis – not analysis

While genetic theories propose that replication is encoded within a modifiable chemical polymer, replication alone is not enough to promote liveliness. A transferrable set of relationships is needed that make sense within a molecular value landscape and pervade beyond the organism itself. These value landscapes are spatially and materially established to favour exchanges between one group of molecule and another that promote their persistence or even autopoetic potential. Specific interactions can therefore be defined for particular molecular species within specific sites that establish a potentiating relationship with its environment, which continues to propagate its generative interfaces and emergent systems, or structures. These potentialities do not reside within one particular set of materials, or within one omnipotent code. They are not entirely attributable to a particular body, or a specific event. Rather, they are implicit in the multiple complex arrangements of matter that shape interactions between bodies and landscapes. These choreographies enable propagative sequences in the web of life to occur.

Since chemical energy sources are discrete and therefore rate limiting when specific metabolisms flourish, light becomes an enabler in this transition from a nonliving planet to one that supports discrete forms of life. The evolution of photosynthesis as a material relationship between chemistry and light [[Footnote: The significance of light as a fabric in the story of biological processes is that it transgresses the boundaries between classical and quantum states. So, it also raises the possibility of quantum phenomena being incorporated into biological systems. The emerging and controversial science of quantum biology embraces these possibilities. An excellent overview of this field is provided by Johnjoe McFadden and Jim Al-Khalili. [McFadden, J. and Al-Khalili, J. 2014. Life on the Edge: The coming age of quantum biology. Bantam Press: London.]].]] emerges from its capacity to continuously bathe large swathes of the terrestrial surface to create an abundant energy landscape that may be captured through a range of molecular systems.

So, when we remove the idea of a particular body, a specific material, or fixed identity from our observation of living systems, we are left with an unbroken set of tactical manouvres that engage with matter, space, time and transformation. Their trajectories are not fixed from the outset but are as diverse as the story of life itself.

These events longer located within the capabilities of single atoms, homunculi or genetic codes, but in more fluid and collaborative operations that do not have well-circumscribed structures. They are produced through the intermingling of fields in which discrete events are propagated. Such platforms can be found in the production of dissipative systems that are paradoxical phenomena. They are structured expressions of matter and energy that are conferred with both object-oriented properties. Simultaneously, they possess the fluid capabilities associated with dynamic systems, or networks of interactions. Dissipative systems also come with their own theory of change that does not rely on accident but embraces a form of self-observation and environmental contingency that results in dissipative adaptation, whereby the structures become optimised to perform particular exchanges within value landscapes that characterise their environment [[**England, J.L. 2015.** *Nature Nanotechnology* **10**, 919–923]].

This does not mean however that life's processes are without limits as the laws of physics, biology and chemistry govern them. Yet, they evade our complete comprehension since they are hypercomplex, dynamic systems that may be highly distributed, heterogenous, massive and constantly changing. Hypercomplex entities include materials such as, biofilms, developmental biology, soils and earth's natural systems – which are the very phenomena through which life is encountered, and most intuitively recognised. Yet, we lack the means of clearly communicating these familiar experiences. Perhaps Arthur C. Clarke's dictum [[Footnote: Clarke's dictum proposes "Any sufficiently advanced technology is indistinguishable from magic."]] could be appropriately applied to natural systems, where 'magic' may be regarded as an irreducible complexity. This idea also holds true for nature itself and has long been drawn on for a source of novelty and potency in occult practices.

In considering an approach towards the aesthetics, poetics and design of living systems, my research explores alternative testable models than established biological conventions. Working with dynamic chemical systems that engage with the potency of matter at non-equilibrium states a lively, non-living world may be explored and iteratively interrogated from a design-led perspective. Here outcomes are not evaluated according to abstracted values such as, speed, mass or temperature change, but within a totality of experience that is more completely embraced through an aesthetic and ethical engagement with the experimental events. Such aesthetics and value landscapes do not seek to constrain the performance of non-equilibrium material systems but may accent, or augment their expression.

In this way natural systems are able to perform spontaneously without being constrained by naturalism or rational functionality (e.g. a peacock has a splendid tail because it is used to attract a mate). Rather than being determined, they would have the freedom to invent, not simply represent dynamic aspects of the material realm (e.g. a peacock's tail transfigures cosmic events). To attend such aesthetics helps resist the compulsion to reduce complexity, to its constituents – and so, engage in the killing of things – that they may be understood through their parts.

A dynamic engagement with aesthetics is necessary to fully appreciate the probabilistic expressions of nature based in the parallel processing capabilities of matter, which is continually expressed through generative interactions with environment. In a hypercomplex reality aesthetics is not about the superficial appearance of things but resonates deeply with the capabilities of the material realm, whose discourses seek to enrich and enliven our experiences. These operations do not attempt to extract, control or reduce encounters with lively matter at far from equilibrium states and may be observed within the body of an agent, or as loose associations between bodies in assemblages. In this context, an aesthetic engagement with living systems assists and encourages materials to develop. Since the rule-sets of the operational systems at work are liberated from the 'top down tyranny' of genetic programs they may establish their own forms of decision-making and types of transformations. The aesthetics and ethics of these exchanges becomes a discourse about transformation and creative expression in these environments.

Yet, where matter possesses such agency and may express itself within broad limits of possibility, architects become codesigners of systems, rather than as top-down controllers of events that limit the fundamental creativity of expression in these systems from the outset. In these systems, the design toolset is not centered on the production of a formal object, or instructing a gene program but through

provoking the possibility of dissipative structures, which spontaneously arises at field intersections and interfaces between media. They are formed by the massive flow of energy and matter through a space. Examples include tornadoes, crystals and galaxies.

Dissipative structures

Ilya Prigogine who won the Nobel Prize for Chemistry in 1977 proposed that dissipative structures underpinned the dynamic nature of living things [[Prigogine, I. (1997). *The End of Certainty: Time, chaos and the new laws of nature*. 1st edition. New York: The Free Press.]]. Yet, if this is true then such systems cannot be fully represented using the traditional tools used to construct objects, or Euclidean geometries, since they are paradoxical agents that are in continual flux and sensitive to their contexts. Engaging with the natural realm through the lens and toolsets invoked by dissipative structures requires an expanded way of seeing life - and in it ourselves. Yet, the tactics for achieving this exceed the capabilities of single atoms, homunculi and genetic codes, but require us to think and design through more fluid and collaborative operations. Although they evade our capacity to fully anticipate their modes of expression, dissipative structures do however possess a striking range of characteristics. They operate through fields of influence that are extruded into the environment and even into each other. Although they are leaky structures that dump energy into their surrounding media, perhaps surprisingly, they tend not to collapse to join with their neighbours but continue to respect their existential boundaries, even if their interactions are loose.

It may be useful therefore, to view dissipative structures as channeling bodies that indicate intersections between potent fields of matter and energy and arise from the field relations of these forces. Yet, because of the amount of energy and matter involved, they can persist for quite some time and exhibit a unique set of properties that are very different to constructing object systems, which are gradually compiled from fundamental components. Dissipative systems also come with their own theory of change – dissipative adaptation - that does not rely on accident but embraces contingency, unpredictability and creativity [England, J.L. 2015. *Nature Nanotechnology*, 10, 919–923.]].

Dissipative structures possess a signature set of organizational typologies. For example, a tornado is produced within an anticipated range of probability where warm and cold air meets. It arises as a swirling spiral of atomized water, with a range of behaviours and trajectories that give us an idea of how it might behave. Owing to the massive flows of energy and material associated with dissipative structures, they create influence beyond their apparent boundaries. For example, the water and air that produce a whirlwind is also released into the environment. A storm chaser feels the wind produced by a twister before they ever get close to the eye of the storm.

Yet, a big challenge remains in relationship to contemporary definitions of life - that these structures do not appear to be able to replicate.

However, the primary organizing system of dissipative structures is not their structural configuration but the field interactions and value landscapes from which they arose. These topologies of distributed chemical systems establish whether dissipative systems will persist, or be produced again within a site. An aesthetics and ethics of these systems must incorporate the potency of field intersections and the environmental character before any meaningful choreography of matter through these systems is possible. Acknowledging the site of genesis of dissipative systems changes our perspective on the site of replication. By strategically overlapping generative fields, a kind of repetition, replication, or persistence of self-similar dissipative structures can be reliably reproduced. For example, if the presence of a tornado in an environment potentiates the generative field differences that make another tornado more likely, then this may be regarded as an act of replication. The new tornado does not need to directly arise from a progenitor tornado but simply be provoked by its spatial and material consequences so that its occurrence is sufficiently frequent to become an expectation of the system. Indeed, if Prigogine is correct, then the persistent occurrence of dissipative systems has already contributed to the unbroken track record of three and a half billion years of liveliness on this planet.

Dissipative systems do not need to be self-similar. We already know that according to the law of dissipative adaptation, they inevitably change the longer they persist and become more efficient at dumping energy into an environment with time by increasing their structural complexity. In other words, their configurations change with time. The principle of dissipative adaptation proposes that in an open environment, matter at far from equilibrium states will self-organise so that it can disperse energy into the surroundings increasingly efficiently. This appears to be a fundamental property of

matter. Dissipation involves an active relationship between a body and its surroundings that facilitates the next manifestation of dissipative structuring in the web of existence. The performing bodies undergoing transformation are operating within a vastly open material landscape where living things cannot be reduced into a simple, logical set of sequences and resists explanations that attempt to trace living systems back to a discrete origin, or initiating event.

This implies that the material constitution of dissipative structures is a secondary concern, not a primary condition for persistence. So, replication in this sense is not about the exact reproduction of structure but the deployment of ongoing tactics to organise fields so they continue to produce dissipative structures. Successful field configurations are likely to exist as autopoietic and autocatalytic configurations - from which objects, spaces and interfaces arise spontaneously. Yet, field interfaces may be prevented from sudden collapse by choreographing the flow of matter and energy in time and space. The evolution of galaxies already shows us that this approach is possible.

Such tactics require very different kinds of understanding than our conventions that discuss cellular cleavage, or the complex dances between sex cells. Perhaps because our concepts are framed by a particular time span, our unavoidable anthropocentrism and inevitable individual mortality, we are looking at the phenomena of life through a very narrow lens. Rather than observing the fate of specific cell lines, perhaps there is much to discover about the story of life by observing the nature and topology of generative fields and how they intersect to produce an unbroken chain of all kinds of life-like phenomena.

By observing dissipative structures through a number of scales it becomes possible to see new potentiality in the community of life through its collective interactions with all kinds of bodies, its infrastructures and appreciate our fundamental similarities with other lifeforms. Such a viewpoint changes our understanding of the project of designing and engineering with life and begins to make alternative suggestions about how we may engage with it architecturally. Such encounters become continuums that are punctuated by field intensities and detailed at intersections.

Dissipative systems therefore offer an alternative way of thinking about life, environment, biology and nature than the dominant, genetically determined programs that dominate cutting edge scientific fields like synthestic biology. They propose an alternative, bottom-up probabilistic, dynamic model of living structures, which relate back to Leduc's notion that synthetic biology is a more sophisticated expression of synthetic chemistry and requires an alternative design and engineering toolset.

Design scrying

In this section I will focus on how it may be possible to design with a discourse of trajectories where there are so many uncertainties in the system. I will attempt to demonstrate how is it possible to design with lively systems without predetermining their outcomes, or being unable to fully discuss their character on account of their apparent instabilities. To do this I will return to methods that were prevalent at a time when uncertainty was an accepted condition of living. Before the Enlightenment, when reduction, empiricization and rationalization sought to bring order to the world, seers wielded "dark arts" that employed a range of techniques, which embraced system instabilities to help in decision-making and foresight. In particular, I will draw upon the art of scrying that uses reflective surfaces to glimpse alternate realities as a means of observing, interrogating and recording the lively interfaces that produce dissipative structures. Scrying comes from the English word "descry" which means "to make out dimly" or "to reveal." Practices use a diverse range of media such as hydromancy, which specifically uses water surfaces as a visualization tool, where the interface between liquid and light becomes a source of symbols that convey possible events or trajectories. The air/water interface has been historically recognized as a gateway to other worlds. Accounts of scrying can be found in practices of Queen Elizabeth I and from the pages written on King Arthur's Merlin as a form of divination. In a design context reflective pools have been widely used throughout history in landscape architecture to mirror and reflect the importance of the site in a cosmological context. The gardens of Versailles designed by André Le Nôtre, Charles Le Brun, Louis Le Vau and Jules Hardouin-Mansart were a complex hydraulic system of fountains and pools that centered the universe on the residence of Sun King Louis VIV. Nostradamus is reputed to have used a black mirror as a specific scrying surface to divine his visions and prediction. The scryer's notion of "the future" is very different to the deterministic, hypothesis that is characteristic of modern experimental science – yet both approaches aim to extrapolate events from the present into a space that has not yet been encountered. While science uses data and mathematical projections to construct models of their visions, scryers empower their

clients by presenting them with a portfolio of potentialities that speak directly to their circumstances. These positions clients in a tangible position of influence, whereby they have a chance to reshape outcomes through remedial action, like the miser Scrooge in Charles Dickens' cautionary tale *A Christmas Carol*. Giving people choice does not make decision-making easy, reduce risks, or guarantee events. However, scrying does empower clients in making difficult decisions, and that is presumably why such services were sought-after.

In a very contemporary context, dark pools are widely used to intensify and produce spectacular views of the landscape and building interiors. Olafur Eliasson's *Inside the Horizon*, a site-specific suite of prism-shaped, sunflower-yellow reflective columns inside Frank Gehry's *Fondation Louis Vuitton* creates a stunning waterway promenade in the institution's grotto. Scrying is not only used to generate dynamic installations but also produce images. Douglas Trumbull exploits the generative power of interfaces to produce analogue special effects for his films such as the *Tree of Life*, which channels cosmological events in the narrative.

In an age where design is increasingly populated with software imaging tools, we rely on mathematical projections to produce images that are separated and distanced from materiality. A consideration of the aesthetics of the dissipative structures that underpin living processes may precipitate new—and empowering—aesthetic possibilities by forging new relationships with matter. The aim is to become co-designers of events with the material realm, extending our influence in ways that enable life, rather than constrain or diminish it.

Since the properties of nonlinear materials, which are present in crystal growth and in the instabilities at oil/water interfaces, are exquisitely sensitive to their environmental context, the air/water interface offers a new platform, with opportunities for making images, structures and even perform useful work. This receptiveness, which ensues from the field instabilities that exist at liquid interfaces, allows designers to co-shape their material performance and aesthetic qualities.

Over the last five years, I have immersed myself in a design context that deals with liquid interfaces, trembling surfaces and turbulent environments. My aim has been to witness and choreograph changes at the field intersections that give rise to dissipative structures. Such a window into the world at the level of interfaces has required a particular kind of engagement, which compelled me to observe and relate these molecular-sale events at the human scale, so that they could be critiqued and applied in design contexts. Yet, beyond reflections and refractions through the interfaces that exist where different media meet, I am interested how the dynamic exchanges may be shaped through molecular forces that underpin the formation of dissipative structures. Rather than observe parallel worlds through perfectly polished and still planes, alternative images can also be generated by field disturbances at these sites to generate projective details of dynamic, unfolding structures that constitute 'living' architectures [[Armstrong, R. (2015). Vibrant Architecture: Matter as CoDesigner of living structures. Berlin: DeGruyter Open.].] [[Footnote: Living architectures are spatial choreographies and design programs that choreograph matter at far from equilibrium states to produce structured experiences that embody some of the properties of living things such as, growth and movement, without being given the full status of being truly 'alive'.]] Methodologically this engagement with interfaces may be regarded as akin to the practice of 'design scrying', which uses unstable boundaries to generate aesthetic discourses that have been historically read as sites of symbol production.

These interfaces can be intensified by dark grounding them, so that the distortions, reflections, refractions and disturbances can be read as probabilistic trajectories against the objects. The images, or symbols, may be photographically recorded and mapped against the site-specific performance of dissipative systems. Design scrying can therefore reveal and channel probabilistic trajectories so potential transformations may become actualities through a series of design-led decisions and material choreographies in which matter itself becomes a codesigner in the system. This method can therefore provide tactics for moving between possibility and practicality so that architects can choreograph the dynamic unfolding of non-equilibrium material events and develop them towards becoming "living" architecture. These probabilistic unfolding material continuums follow trajectories that may be ascertained through the exchange of information at interfaces. The aesthetics of these encounters channel the various exchanges between multiple fields and bodies, to generate sketches and prototypes. Disturbances at liquid interfaces can be regarded as visualization tools for examining otherwise invisible networks of interactions, and their potential. The graphical outputs suggest possible relationships between fields that may evolve from ongoing exchanges into landscapes of possibility—transitional states of being that are shaped over time by their responses to elemental systems. At these

sensitive interfaces tangible configurations may be repeatedly stretched and collapsed as they promise potential methods of architectural construction in the deposition of soft scaffoldings. In their unstable moments of existence, these fluid interfaces offer vistas that can be photographically recorded. As the images in these photographs extend out to make certain bonds in one dimension and withdraw from others in another, the liquid landscapes they display continually evolve, revealing fields of interactions within probabilistic fields. These images may be thought of as "elemental drawings," which can provide an alternative to the software packages that constrain the aesthetics of modern practices.

The choreography of light, water and air demonstrates the vibrancy and impact of what we would conventionally think of as invisible media, or are formless, which bears little relevance to the production of objects. However, documentation of these fields reveals incredible molecular forces at work on pluripotent substrates which afford value landscapes and material networks with transformative potential that may be incorporated into design processes. A range of different approaches can act as gateways to channel and explore new architectural possibilities that can channel the potential trajectories of natural forces such as, 3D printing and natural computing techniques. [[Footnote: Natural computing is a new field of scientific investigation that directly harness the computational capabilities of the living realm, which was of interest to Alan Turing [[Turing. A.M. (1952). The chemical basis of morphogenesis. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, 237(641), pp.37-72.]].]]

Dark gels

To produce, capture and examine a range of aesthetic encounters with the apparatuses of design scrying, a series of dark gels were constructed. These were excitable media, which consisted of alkali-activated agar (IM ammonium hydroxide in 2% agar), whose substance channeled the performance of enlivened inorganic salts - 1M solutions of Nickel, Chromium, Manganese, Iron II, Iron II and Copper II. The system was inspired by the dissipative chemical waves of the Liesegang Ring experiment, which was first developed by Raphael Liesegang who was interested in developing light-sensitive gels for photography. He observed spatial time-independent structures that are produced from the interactions between non-uniform fields of agents, specifically in the presence of potassium dichromate and silver nitrate. Liesegang rings are observed when symmetry in the excitable media is broken by an initial spatial concentration gradient that prompts a wave of reagents to move through the system. Procedurally, the modified Liesegang Ring experiment extends the range of interacting chemical species and speaks of an origins of life style transition that is unconstrained by naturalized aesthetics, where the 'qualia' [[Footnote: qualia is a unit of sensory information, or 'feeling']] of interacting lively materials orchestrate new independent acts of creation. Interfaces, from which dissipative structures might emerge, were established at the surface of the gel and also through diffusion and periodic precipitation and re-dissolution waves of complex salts performed.

The production of images is obtained at interfaces that are constructed through juxtaposing reactive fields with the potential to produce dissipative structures. Activated gels were designed to propagate waves of self-organizing chemistry through a semi-liquid interface with the air. Light is reflected, refracted and diffused at the gel surface to produce distortions that are photographed to document the transformation in the system. Disturbances in the transmission of light are produced by the different refractive indices of the interacting fields and media, as well as waves of chemical precipitation that produce opacities that cause scatter.

The activated gel matrix enabled the selective permeability and movement of matter through the design field. The reaction-diffusion interaction between cation and anion pairings enabled material transformation to occur. Physical forces such as, diffusion and gravity - and chemical transformations such as, crystal precipitation - choreograph the interactions between these multi material dynamic agents. The width and spacing of the bands of crystal precipitation varies according to a variety of starting conditions, such as their distance from the origin of the imposed concentration gradient. Further complexity was introduced into these architectural agents by placing the system in an open petri dish, rather than the traditional vessel – a boiling tube. This encouraged lateral diffusion in the system and provided access to multiple sites for choreographing a dynamic topology of multi material transformations and surface reconfigurations. The activated fields also generate a dynamic topology within the gel architecture as waves of salt solution produce cross linking of the carbohydrate polymers that start to contract like muscles, causing the matrix to buckle, roll and fold like a developing embryo.

The activated gels were lit against dark surfaces such as, black card so that light channeled across their surfaces could be photographically documented and propose an alternative, artificial embryogenesis. The choreography of these surfaces has not been segmentalised, or organized by centralised genetic

programs and is still radically open to environmental influences working through fundamental material relationships. The aesthetics produced at the dark gel interfaces discuss alternative possible evolutionary pathways of events and even suggest new kinds of nature that given the right propagative fields could potentially persist within the site as soils, bodies, or architectures. The gels are always moving. They duck, dive and advocate alternative configurations. They resist formalization leading us towards an aesthetics in motion whose qualities evade fossilization through pre-ordained forms but enable new kinds of image making and spatial programs through revealing connections that were previously unseen.

As in all aesthetic discourses preferences are invoked. Yet, in a dark gel environment, there are no pre-set Platonic ideals in which an a priori set of qualities has any intrinsic value over another. Through activating a generative media, the system is open to all emerging aesthetic narratives that propagate new kinds of relationships with matter and identification between bodies through the community of life. These open selection approaches differ significantly from the culling that takes place in virtual life forms such as, Carl Sims, William Latham and Greg Lynn's algorithmic explorations of morphological transformations in which aesthetics becomes a destructive act of negative (de)selection at the level of producing a final object.

Aesthetic choices in design scrying are also made at a much earlier stage in system's performance than in an object-centred design practice which enables decisions to be made without removing the capacity of the system to surprise and therefore enable unexpected events and change in the system. As such, the dark gel body becomes a site for the emergence of spatialized material encounters, forms of being and ultimately - new natures. Dark gel scrying offers an inclusive set of decisions that facilitate the potency and creativity of the natural realm.

The resultant images point to terrains for architectural design through the emergence of new images, methods of construction and a way of reading nonlinear landscapes. Yet, like the transitional states of chemistry, we are not observing constants but the highly variable and processual properties of matter. Furthermore, design hydromancy is not a discrete material or technology, but constitutes a design fabric that is semi-permeable to its liquid landscapes that may obtain new significance as they pass through chemically primed value landscapes. For example, a chemically cracked gel surface becomes a landscape of artificial flesh that implies convergence between organic and inorganic fields of propagation (see, Figure 1).

Figure 1:
Credit: Photograph courtesy Rachel Armstrong, 2015
Caption: ***Artificial flesh – the splitting of a gel enables salt solutions to meet and precipitate, the fractured surface can be seen through the light reflections. The gel medium is dark grounded as blood red, which intensifies the traces as symbols of aesthetic intent that inform the design process.***

Other images suggest the formation of the alchemical peacock's tail, a symbol of hope and progress (see, Figure 2).

Figure 2:
Credit: Photograph courtesy Rachel Armstrong, 2015
Caption: ***Peacock's Tail. Out of the blackness of the alchemist's despair (Putrefaction) comes a brilliant display of colors and meaningful visions (the Peacock's Tail.)***

Design scrying opens up access to an image-generating system that enables alternative forms of material computation and production of 'living' structures. These toolsets enable a new set of design techniques that enable the choreography of space that are independent from digital systems. This toolset does not generate fixed solutions, but helps visualize matter in a probabilistic context, where events and objects are equally important as they arise simultaneously from generative fields. A toolset based on the performance of dissipative structures that are observed through their sites of origin offer new insights into considering living systems as a potential design fabric and provokes multiple ethical and procedural questions that warrant further experiment and investigation.

Towards an aesthetics of synthetic biology

In the 3rd millennium 'life' is the common project for humanity as we negotiate our ongoing survival as a species on this planet. Within the challenging and highly tempestuous environment architects wield

significant influence on the fabrics that are unique to this planet. Collectively they comprise a force capable of geoengineering-scale impacts. They are simultaneously navigators, communicators, inventors, visionaries and risk takers that are not afraid of the unknown. Yet, if we are to observe different kinds of outputs than the impacts that we have come to expect from the practice of modern architecture, which necessarily cause environmental harm through decreasing the liveliness of environments, then new ways of viewing the environment and the bodies within it are needed so that we may begin to observe, imagine, design, engineer and choreograph matter differently.

A toolset of living systems provides architects with a first-principles approach towards choreography of matter that has the potential to produce nothing less than new kinds of Nature from which alternative intelligences, gastrulating structures, and production platforms for human development begin to emerge. These substrates arise from alternative value systems and method of making architecture that are based in the performance of dissipative structures and their embedded environmental systems. Within these placental enfoldings new architectural strategies, programs and tactics are made available for iterative, persistent experimentation to explore these terrains. Rather than seeking atomic control of events, they embrace risk as a condition of existence and develop a broad palette of lively, multi materialities that incessantly coalesce to provoke new spatial experiences.

The resultant material systems, malleable scaffoldings and 'living' architectures are much more like soils than traditions that seek the production of objects. These living bodies and lively environments change continually with time and possess discrete lifespans. They are sown, not manufactured. They arise all at once – and are not built from a series of discrete parts. They are provoked into existence as a sudden dissipative seed of organizing multi materialities. Material choreographies are unique and follow individual developmental trajectories, which are entangled with the character of the site. These living architectures grow as a consequence of transient alliances and material assemblages. Their bodies remain semi-permeable to their sites as porous, rich gelatinous frameworks. These proliferate, are canalized and gradually harden through their permeability to mineral-rich flows. Spatial variation within their planes and localities give rise to tissues and membranes that form between many loosely associating materials. They generate organizing hubs that roll and fold to produce architectural-scale, metabolic organs, which shape the physiology of sites.

Such systems do not seek permanence or self-similarity – but over their active lifespans produce new morphological layers that deposit minerals in their bodies, leaving behind new substrates for further growth. These forms of propagation and material extension do not require central spatial plans, or deterministic programs. Instead, they bud off seedling fabrics and breed new architectures as a bespoke range of embryological architectural events. They bring another set of expectations to design practice and the choreography of space as they may senesce as they break down. Yet, these 'errors' are not terminal events to be deselected, but value landscapes and opportunities for the emergence of new programs. As one dissipative system collapses, it provides a complex material platform as the starting point for another iteration, or cluster, of lifelike events that resist chaotic decoherence and collectively, yet specifically, enrich environmental fertility.

"Living" architectures are not without architects. Countless bodies codesign them - although many of these are not human. They are not constrained by established by conventional building typologies but create the conditions for the emergence of new places, which are shaped by spatially contingent events - such as, energy and resource distribution. Such complex relationships are not panaceas but provoke new values ethics and relationships around contested sites that are as rich, varied and robust as life itself.

Such new toolsets open up new roles for architects, which are based in a sensibility and partnership with the living realm. New skillsets are also required as designers work with fuzzy surfaces, cloudy vistas, fragile details, quantum logic, soft scaffoldings and all kinds of teratogenic in-betweens that infiltrate the spandrels between the mineralized bones of industrial construction, Yet these nascent terrains and complex, fertile substrates do not claim to provide totalizing solutions to the constantly unfolding multiplicities and challenges that we are facing. Rather, they catalyze new opportunities for invention by providing an emerging palette of new possibilities and paradoxes from which we may new kinds of architectures may be birthed. In their very essence these material choreographies are compatible with 'life'. In this way the built environment begins to share a common project with the natural realm that can be shaped by human ethics and environmental value systems. These are midwifed into existence through the production of life's poetry, which invite our mutual, continued survival into an ever-unfolding adjacent possible that is full of surprises.

Notes

Illustration Credits

arq gratefully acknowledges: All photographs taken by Rachel Armstrong, 2015.

Acknowledgements

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Rachel Armstrong is Professor of Experimental Architecture at the School of Architecture, Planning and Landscape, Newcastle University. She is a Rising Waters II Fellow with the Robert Rauschenberg Foundation (April-May 2016), TWOTY futurist 2015, Fellow of the British Interplanetary Society and a 2010 Senior TED Fellow. She works with the computational properties of the natural world and the productivity of soils. She calls the synthesis that occurs between these materials, systems, technologies and their inhabitants "living" architecture.

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CAPTIONS:

Figure 1:
Credit: Photograph courtesy Rachel Armstrong, 2015
Caption: Artificial flesh – the splitting of a gel enables salt solutions to meet and precipitate, the fractured surface can be seen through the light reflections. The gel medium is dark grounded as blood red, which intensifies the traces as symbols of aesthetic intent that inform the design process.

Figure 2:
Credit: Photograph courtesy Rachel Armstrong, 2015
Caption: Peacock's Tail. Out of the blackness of the alchemist's despair (Putrefaction) comes a brilliant display of colors and meaningful visions (the Peacock's Tail.)

WEB ABSTRACT (300 words):

In 1911, Stephane Leduc originally proposed that synthetic biology is a branch of synthetic chemistry that can offer a portfolio of design tools that broaden the possibilities of an aesthetics of life. In the production of generative fields that underpin the synthesis of living systems, life-like materials may be transfigured and transformed without being constricted by naturalistic expectations. The role of 'design scrying' in this exploration is discussed

particularly in the generation of images through the interface distortions that occur at the surfaces of ‘dark gels’. These non-deterministic image generating media enable discussion of the aesthetics of life that enable designers to venture beyond the conventions of representation in the natural sciences and synthetic biology, as it is currently practiced in scientific laboratory settings. The implications of this approach are considered through the possibility of using lifelike materials in the choreography of space where lifelike materials, trembling interfaces and living technologies give rise to the emergence ‘soft living architectures’. These establish the possibility of the development of living spaces that possess some of the properties of living things but may not have the full status of being truly alive.

PULL QUOTES (if no illustrations):